Sex ratio distribution in the Siberian Tiger *Panthera tigris altaica* (Mammalia: Felidae)

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Abstract

Sex ratio distribution was studied in 652 litters of the Siberian Tiger *Panthera tigris altaica*. It was found to be simply binomial, both at birth as well as after 3 months of kitten's life, when much of their early postnatal mortality was found to be finished. Overall sex ratio (males to females) was 0.962 at birth and 0.910 three months later. The deviation from unity was found to be statistically non-significant in both cases.

These data do not support the theory that females are capable of adjusting the sex ratio of their offspring.

Introduction

Although the sex ratio belongs to the most vividly discussed problems in the contemporary theoretical ecology (see, e.g., Trivers and Willard 1973; Charnov 1975; Williams 1979; Clutton-Brock 1982), only very few data regarding the statistical distribution of sex ratio in clutches or litters were published thus far. Because the data of this kind are of importance for the current discussion of various theories attempting to solve evolution and ecological importance of the sex ratio (Harmsen and Cooke 1983), I decided to present here an analysis of the sex ratio distribution in the Siberian Tiger *Panthera tigris altaica* (Temminck 1845).

Material and methods

The data on the litter size and sex composition of individual litters were extracted from published International Tiger Studbooks (Seifert and Müller 1976, 1980). They are, hence, considering captive animals. Overall, data on 652 litters and 1654 newborn Siberian Tigers were available for the purposes of this study. 22 additional litters in which the sex of one or more kittens was not identified were excluded from this analysis. This action has apparently no effect on the results obtained (see Lombardo 1982).

Sex ratio distribution was calculated for each litter size separately, first at the time of birth and, second, at the kitten's age of 3 months. Standard statistical procedures as described in Sokal and Rohlf (1969) were used.

Results and discussion

Sex ratio

Data presented in the Table 1 show that the overall sex ratio at birth does not depart from unity in Siberian Tiger. This result agrees well with the expected unity sex ratio in monogamous species (Darwin 1871; Fisher 1930; Crew 1937; Edwards 1962; Maynard Smith 1978) to which Siberian Tiger belongs (Mazák 1979).

On the other hand, Fisher (1930) suggested that the overall sex ratio at birth should depend on the relative cost of production of the two sexes (see also Kolman 1960;

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Bodmer and Edwards 1960; Macarthur 1965; Verner 1965; Leigh 1970; Spieth 1974). In the Siberian Tiger, birth weights of males seem to be higher than those of females, although the data are still insufficient (Mazák 1979). Hence, according to Fisher's hypothesis, the expected overall sex ratio should be skewed toward females. This is obviously not the case in the Siberian Tiger (see Tab. 1) which agrees in this respect with various size dimorphic birds (see Selander 1960, 1961; Howe 1976, 1977; Newton 1979; Newton and Marquiss 1979; Fiala 1981; Richter 1983).

Table 1

Overall sex ratio in litters of Siberian Tiger *Panthera tigris altaica* at birth

Litter size	No. of litters	N♂	(%♂)	N♀	(%♀)	$\frac{N♂}{N♀}$	X^2
1	113	59	(52.2)	54	(47.8)	1.093	0.111*
2	212	194	(45.8)	230	(54.2)	0.843	1.528*
3	207	311	(50.1)	310	(49.9)	1.003	0.0008*
4	104	203	(48.8)	213	(51.2)	0.953	0.120*
5	16	44	(55.0)	36	(45.0)	1.222	0.400*
together	652	811	(49.0)	843	(51.0)	0.962	0.310*

* Not significant at p = 0.1

It is obvious that early postnatal mortality may, if differential, change the secondary sex ratio. To investigate its possible effect I calculated the overall sex ratio for kittens which survived first three months of their life. Although it decreased from 0.962 to 0.910 during that time period (see Tab. 2), the deviation from unity was again found to be statistically not significant, and the effect of early postnatal mortality on the overall sex ratio could be, then, rejected in the Siberian Tiger.

Table 2

Overall sex ratio in litters of Siberian Tiger *Panthera tigris altaica* three months after birth

Litter size	No. of litters	N♂	(%♂)	N♀	(%♀)	$\frac{N♂}{N♀}$	X^2
1	146	70	(47.9)	76	(52.1)	0.921	0.123*
2	174	161	(46.3)	187	(53.7)	0.861	0.971*
3	150	214	(47.6)	236	(52.4)	0.907	0.538*
4	53	105	(49.5)	107	(50.5)	0.981	0.009*
5	6	15	(50.0)	15	(50.0)	1.000	0.000*
together	529	565	(47.6)	621	(52.4)	0.910	1.322*

* Not significant at p = 0.05

Sex ratio distribution

The expected statistical distribution of the sex ratio within litters is the binomial one (e.g. Edwards 1962). There are, however, several theories on why and under which conditions the sex ratio may or even should be non-binomial.

First, Verner (1965), Charnov (1975) and Taylor and Sauer (1980), among others, suggested that for females it should be selectively advantageous to produce equal numbers of sons and daughters. If so, the sex ratio distribution should deviate from the binomial one

Table 3

Sex ratio distribution in litters of the Siberian Tiger *Panthera tigris altaica* at birth

Litter size	No. of litters	♂ : ♀	No. of litters observed	No. of litters expected	X^2
2	212	2 : 0	46	44.5	0.200*
		1 : 1	102	105.3	
		0 : 2	64	62.3	
3	207	3 : 0	33	26.0	3.921*
		2 : 1	66	77.8	
		1 : 2	80	77.5	
		0 : 3	28	25.7	
4	104	4 : 0	5	5.9	0.897*
		3 : 1	28	24.8	
		2 : 2	36	39.0	
		1 : 3	27	27.2	
		0 : 4	8	7.1	
5	16	5 : 0	1	0.9	0.821*
		4 : 1	3	3.3	
		3 : 2	5	3.8	
		2 : 3	5	4.4	
		1 : 4	2	1.8	
		0 : 5	0	0.3	

* Not significant at p = 0.1

Table 4

Sex ratio distribution in litters of the Siberian Tiger *Panthera tigris altaica* three months after birth

Litter size	No. of litters	♂ : ♀	No. of litters observed	No. of litters expected	X^2
2	174	2 : 0	38	37.3	0.052*
		1 : 1	85	86.5	
		0 : 2	51	50.2	
3	150	3 : 0	18	16.2	0.409*
		2 : 1	51	53.4	
		1 : 2	58	58.8	
		0 : 3	23	21.6	
4	53	4 : 0	2	3.2	9.119*
		3 : 1	20	13.0	
		2 : 2	11	19.9	
		1 : 3	15	13.5	
		0 : 4	5	3.4	
5	6	5 : 0	0	0.2	0.433*
		4 : 1	1	0.9	
		3 : 2	2	1.9	
		2 : 3	2	1.9	
		1 : 4	1	0.9	
		0 : 5	0	0.2	

* Not significant at p = 0.05

towards less variance (Harmsen and Cooke 1983). This is not the case in the Siberian Tiger (see Tab. 3), as well as in the Lesser Snow Goose *Anser caerulescens* (Harmsen and Cooke 1983), Eastern Bluebird *Sialia sialis* (Lombardo 1982), and Man *Homo sapiens sapiens* (Geissler 1889; Edwards 1958; Edwards and Fraccaro 1958, 1960). However, the data available are still too scarce to allow a substanciated rejection of this theory.

Second, if different females are genetically predisposed to produce either more sons or more daughters (see Hohenboken for review), the sex ratio distribution should deviate from the binomial one toward greater variance (Harmsen and Cooke 1983). Such a deviation was actually observed in one study on Man (Geissler 1889; Edwards 1958), but neither in another one (Edwards and Fraccaro 1958, 1960), nor in the Siberian Tiger (see Tab. 3), Lesser Snow Goose (Harmsen and Cooke 1983), and Eastern Bluebird (Lombardo 1982).

Because deviations from the binomial distribution required in both of the theories mentioned above may not be apparent at birth, but may be reached by differential mortality of young soon after birth, I tested this by calculating the sex ratio distribution in litters at the 3 months age of Siberian Tiger kittens, when much of their juvenile mortality was found to be finished (468 = 28.3 % of 1654 kittens born were dead at that time). In this case, too, the sex ratio distribution was found to agree quite closely with the expected binomial one (see Tab. 4), so that, again, the theories mentioned above could not be supported.

Zusammenfassung

Das Geschlechterverhältnis und seine Verteilung beim Sibirischen Tiger Panthera tigris altaica (Mammalia: Felidae)

Das Geschlechterverhältnis und seine Verteilung wurde bei neugeborenen und drei Monate alten Sibirischen Tigern in Zoologischen Gärten berechnet. Bei der Geburt war es bei 1654 Jungtieren 0,962 (♂ zu ♀), drei Monate später bei 1186 überlebenden Jungtieren 0,910. Die Abweichung von 1 war in keinem Fall signifikant. Die Verteilung des Geschlechterverhältnisses in den einzelnen Würfen wich weder bei der Geburt noch drei Monate danach signifikant von einer Binomialverteilung ab.

Diese Daten unterstützen nicht die Theorie, daß die Weibchen das Geschlecht ihrer Nachkommen beeinflussen können.

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WISSENSCHAFTLICHE KURZMITTEILUNG

Die saharischen Vorkommen von *Eliomys* Wagner, 1840

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Forschungsinstitut Senckenberg, Frankfurt a. M.

Eingang des Ms. 30. 7. 1984

Die Variationsbreiten von Färbung (besonders des Schwanzes), Ohrgröße und Schädelproportionen bei n-afrikanischen Gartenschläfern des Formen-Komplexes *Eliomys quercinus munbyanus – E. melanurus* wurden zuletzt von Kahmann und Thoms (1981) untersucht.

Zum weiterführenden Verständnis der Beziehungen von *munbyanus* (Pomel, 1856) (terra typ.: Oran, NW-Algerien) und den Taxa, die als Mischformen bzw. Übergänge zu *melanurus* Wagner, 1839 (loc. typ.: am Mt. Sinai) angesehen werden, nämlich *lerotina* (Lataste, 1885) (loc. typ.: Ghardaia), *tunetae* Thomas, 1903 (loc. typ.: Kairouan, Zentral-Tunesien), *occidentalis* Thomas, 1903 (einschließlich *riggenbachi* Heim de Balsac, 1936: 332, lapsus; loc. typ.: Rio de Oro = Umgebung von Villa Cisneros), *cyrenaicus* Festa, 1922 (loc. Typ.: Gheminez, Cyrenaica, Libyen) und *denticulatus* Ranck, 1968 (loc. typ: El Gatrun, Fezzan, Libyen) empfehlen Kahmann und Thoms (1981) im Gebiet der libysch-algerischen Grenze, im NE-Fezzan und Zentral-Libyen weitere, bisher nicht bekannte

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